POPULATION STRUCTURE AND HABITAT COMPONENTS OF A NON-HUNTED ARGALI POPULATION IN THE EAST GOBI, MONGOLIA[1]

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[1]Accepted April, 2003
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Argali Sheep ground surveys and plant community studies were conducted on a 163.8 sq. km portion of a 607.4 sq. km study area in the eastern Gobi during 1993 and 1998. The Steppe plant community consisted of 27.1, 25.1, and 13.7 percent grasses/sedges, shrubs and forbs, respectively, including 20 species of forbs, 7 of grasses, and 4 of shrubs. A total of 162 Argali (15 ewes, 8 lambs, 99 rams and 40 unclassified ewes and lambs) were observed in 1993, and 171 (70 ewes, 28 lambs, 33 rams and 40 unclassified ewes and lambs) in 1998. Argali densities were 0.99 per sq. km in 1993 and 1.04 per sq. km in 1998, indicating a stable trend. The high ram numbers in larger size classes (>50%) and average age at natural death of 9 years (range 6-13) indicate that the rams survive to an old age. A ratio of 40 lambs : 100 ewes in 1998 indicate an increasing population. This Argali population is probably viable due to favourable forage conditions, curtailed illegal hunting, unfragmented habitats, and stable numbers.

Key words: Argali, Gobi Desert, habitats, Mongolia, monitoring, *Ovis ammon*, population trends, wild sheep

INTRODUCTION

Argali (*Ovis ammon*) wild sheep occur in temperate mountainous, steppe, and desert, undulating and rugged habitats of central Asia, including Mongolia (Valdez 1982, Geist 1991). Two subspecies of Argali occur within Mongolia, the Altai Argali (*O.a. ammon*) of western Mongolia and the Gobi Argali (*O.a. darwini*) of the Gobi Desert in southern Mongolia. They are listed as rare by the Mongolian Ministry for Nature and Environment (MNEM 1997) and are on the United States Fish and Wildlife Service list of endangered and threatened wildlife and plants (USFWS 1997). In addition, they are listed as vulnerable and endangered by the IUCN (2000), and in Appendix II of CITES (USFWS 2001). Mongolia encompasses 1,656,000 sq. km, of which approximately 25% is potential Argali habitat (ASM 1990), but only about 61.5 sq. km are included in protected areas (MNEM 1997). Limited sport hunting by foreign hunters who currently pay up to $50,000 for a hunt has been permitted since 1968. The current Mongolian law on hunting established in 1995 and administered by the Mongolian Ministry for Nature and the Environment regulates the commercial use of wildlife. Hunting fees are an important source of foreign currency in a badly depressed economy (MNEM 1995).

Argali populations declined throughout Asia during the last Century (Harper 1945; Mallon 1985; Heptner *et al.* 1989; Fedosenko *et al.* 1995; Mallon *et al.* 1997; Reading *et al.* 1997), but specific population status and trend information, although a fundamental requirement for conservation (Wegge 1997), is lacking. In this paper, we document habitat conditions, population status and trend for a non-hunted Argali population in the eastern Gobi of Mongolia. This is the first such published study for Argali in Mongolia. Population trend data is essential for managing populations and for comparing with hunted populations.

STUDY AREA

The 607.4 sq. km study area is situated in the Ikh Nartiin region of the East Gobi Aimag (province) south of the village of Chayr (Fig. 1) in a steppe landscape characterised by undulating terrain and large rocky outcrops (Fig. 2). The study area is within the Ikh Nartiin Nature Reserve established in 1996 to protect the scenic landform (Myagmarsuren in Kenny *et al.* 2001). The entire study area is Argali habitat. Elevations range from about 1,220 to 1,300 m and average annual precipitation is about 200-250 cm (ASM 1990). The daily temperature is $\geq$ 10 °C for 110 to 130 days per year and the average annual daily temperature is about 2 °C (ASM 1990). January is the coldest, with temperatures of -40 °C or colder in contrast to > 38 °C during summer. Dry gullies or draws are dispersed throughout the area and the only permanent stream is situated in the northwestern portion. The land ownership is public and devoted to raising livestock on open range. There are few paved roads and motorised vehicles are infrequent. Domestic animals include cattle, sheep, goats, camels, and horses, with sheep predominating. Wolves (*Canis lupus*) are the only large predators present.

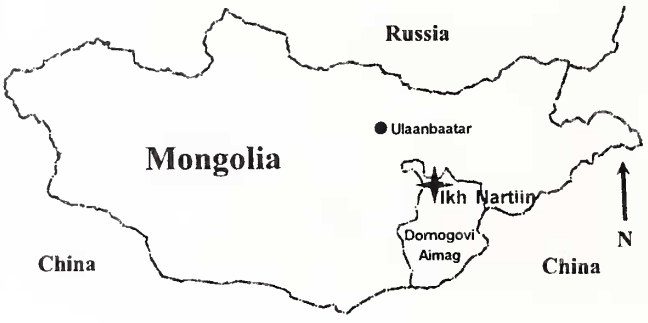

Fig.1: Location of the Ikh Nartiin study area in southeastern Mongolia

Steppe plant communities in Mongolia are complex (Hilbig 1995; Gunin *et al.* 1999). ASM (1990) described this portion of the eastern Gobi as steppe dominated by needle grasses (*Stipa klemenzii* and *Stipa krylovii*) and *Cleistogenes squarrosa*. In the study area, other grasses included fescues (*Festuca* spp.), and wheatgrasses (*Agropyron* spp.). A tall robust grass, *Achnatherum splendens* is dominant in gullies or draws. A variety of forbs including wild onion (*Allium* spp.), and shrubs such as sagebrushes (*Artemisia* spp.), caraganas (*Caragana* spp.), salt cedars (*Tamarix* spp.), junipers (*Juniperus* spp.), currants (*Ribes* spp.), and cherry (*Prunus* spp.), were common components in plant communities at Ikh Nartiin.

METHODS

Wild sheep were systematically surveyed in the study area on September 9-10, 1993 and October 8-9, 1998. Sheep surveys were conducted on foot from approximately the same observation points and along the same ridgeline travel routes during both years. Sheep were also observed from jeeps when travelling between observation points. Drop off points, base camp locations, and observation points were documented using GPS technology. Animals were observed with the aid of 8x and 10x binoculars and 10x - 45x spotting scopes. One observation group, consisting of 3 to 4 experienced observers, went into the field together each day to observe sheep. Censuses were conducted over a 2-day period because it allowed sufficient time to adequately cover the area and to minimize counting the same animal more than once. When the possibility existed that the same animals were observed more than once, only the first observation was recorded to minimize error. Location and altitude of sheep observation sites were recorded using GPS technology.

Observed Argali densities were determined by dividing the number of animals observed by the size of the survey area. Each sheep observed was classified into one of the following categories; adult ewe, lamb, or ram. Rams were classified into size classes based on horn length (Geist 1971; Fedosenko *et al.* 1995) as follows: Class I (1-2 years old), Class II (3-4 years old), Class III (5-6 years old) and Class IV (>6 years old). Cause of death of ram carcasses found in the field was determined by the remains. If most of the skeleton including the head and horns was present, death was assumed to be from natural causes. In a few cases, local herders directed us to the remains of Argali that had died during winter.

In 1998, the plant community at Ikh Nartiin was quantified by recording species composition, canopy coverage, and frequency of occurrence for plants along four 60 m long line transects using the method of Daubenmire (1959). English common names for plants are included when available, otherwise common names are omitted. On October 10, 1998 data from 20 quadrats (20 x 50 cm) were recorded along each of the 4 line transects (total 80 quadrats). Quadrats were placed at 3 m intervals along each transect line. Each plant species and form class within a quadrant was determined to be in 1 of 6 different percent cover classes: 1 = 0-5%, 2 = >5-25%, 3 = >25-50%, 4 = >50-75%, 5 = >75-95%, 6 = >95-100%. Percent cover was summarized by using the midpoint for each cover class recorded to determine the mean. Frequency of occurrence was determined based on the number of quadrats in which the species occurred. Transects were established at representative upland sites where Argali had recently been observed. Riparian vegetation associated with one perennial unnamed stream in the study area was described by developing a species list of the plants observed in the riparian zone.

RESULTS AND DISCUSSION

Vegetation Structure and Composition

The steppe plant community consisted of 27.1, 25.1, 13.7 percent grasses/sedges, shrubs, and forbs respectively (Table 1). Grasses/sedges, forbs, and litter or old plant material were the most frequently occurring vegetative classes. The most diverse vegetative class was forbs with 20 species followed by grasses and sedges with 7 species each and shrubs with 4 species. Total cover does not equal 100% because plant communities are composed of plants of varying heights, thus in reality the ground may be covered more than once due to a layering effect.

All plants observed were natives, many of which are palatable to a variety of wild and domestic ungulates (Bespalov 1951; Heptner *et al.* 1989; Bedunah and Miller 1995; Frisina and Gombosuren 2000). Because species composition varies by season, data in Table 1 most accurately depict species present late in the growing season. The third highest cover class (14.0%) and most frequently occurring class

(98.8%) was litter or old plant material.

Four species of grasses (*Koeleria muhdensis*, *Stipa krylovii*, *Achnatherum splendens* and *Cleistogenes squarrosa*) frequently occurred along or near stream banks and throughout the floodplain. *Carex durusicula*, a sedge, was also frequently observed. Small, scattered clumps of Siberian Elm (*Ulmus pumila*) were occasionally present in gullies. Three species of shrubs (*Armeniaca sibirica*, *Ephedra monosperma* and *Caragana leucophloea*) were observed. *Artemisia xerophytica*, *Allium polyrrhizum*, and *Convolvulus ammanii* were associated forbs. All plants observed within the riparian and associated flood plain were native to the area.

Table 1: Canopy coverage and frequency of taxa in the steppe plant community at Ikh Nartiin

Form Class and species	Canopy Cover (%)	Frequency of occurrence (%)
Grass/Sedges	27.10	96.25
Agropyron cristatum	0.69	10.00
Carex durusicula	0.19	7.50
Cleistogenes squarrosa	3.66	83.75
Koeleria glareosa	0.25	10.00
Koeleria gracilis	0.38	15.00
Koeleria muhdensis	6.03	32.50
Sitpa krylovii	13.82	85.00
Shrubs	25.14	30.00
Caragana leucophloea	3.28	22.50
Ephedra monosperma	0.06	2.50
Ephedra sinica	0.22	2.50
Unknown Shrub	0.47	2.50
Forbs	13.66	92.50
Allium polyrrhizum	2.41	23.75
Arenaria capillaris	0.13	5.00
Arenaria sibirica	0.88	5.00
Artemisia adamsii	0.03	1.25
Artemisia frigida	4.00	55.00
Artemisia klemenzii	0.41	10.00
Artemisia spp.	0.06	2.50
Asparagus dahuricus	0.41	10.00
Astragulus mongolicus	0.03	1.25
Astragulus spp.	0.10	5.00
Corispermum mongolicum	0.06	2.50
Corispermum orientalis	0.25	3.75
Dontostemon integrifolius	0.03	1.25
Heteropappus hispidus	0.10	3.75
Iris bungei	0.03	2.50
Orostachys spp.	0.03	1.25
Potentilla leucophylla	0.03	1.25
Rhamnus erythroxylon	1.11	2.50
Unknown Brassicaceae	1.00	40.00
Unknown Forb	1.01	3.75
Mosses & Lichens	1.10	21.25
Rock[a]	19.41	71.25
Bareground	42.19	97.50
Litter	14.01	98.75

[a] rock is a stone greater than 2.5 cm in circumference

Cover and frequency of occurrence for the physical characteristics of bareground and rock were measured (Table 1). Cover of bareground (42.2%) dominated, which is typical of arid plant communities. Rock (19.4%) was also an important cover class. Rock and bareground were present on the majority of plots. Plant cover in the Gobi region is typically sparse (Bespalov 1951).

Argali Population

Total sheep observed in 1993 and 1998 were 162 and 171 respectively, of which 122 were classified by sex or age in 1993 and 131 were classified in 1998 (Table 2). Forty sheep that were either ewes or lambs were observed in 1993 and 1998, but could not be differentiated and were thus not included in Table 2. However, they were included in calculating Argali density and in tabulating the number of rams observed in the population. Of the 99 rams observed in 1993, 52 were classified into age classes and all 33 rams observed in 1998 were classified into age classes. The observed ram age structure was 13 Class I, 7 Class II, 23 Class III, and 9 Class IV in 1993 and 1 Class I, 12 Class II, 2 Class III, and 18 Class IV in 1998.

Population Density

A population density of 0.99 Argali per sq. km was recorded in 1993 and 1.04 Argali per sq. km in 1998. These data indicate a stable trend in population density at Ikh Nartiin. Population densities observed in the eastern Gobi are similar to the 1.0-1.2 per sq. km for Marco Polo's Argali (*O.a. polii*) observed by Heptner *et al.* (1989) and the 1.3 per sq. km reported for Tibetan Argali (*O.a. hodgsoni*) by Jie and Sheng (1990) in China's Qinghai Province. Fedosenko *et al.* (1995) observed 2.5 Marco Polo's Argali per sq. km in Kirghizstan within a protected area with limited hunting. Reading *et al.* (1997) observed a much lower Argali density of about 0.019 per sq. km during an August 1994 aerial survey over 4,552.5 km of transects in Mongolia's south Gobi. However, they included large areas of unsuitable Argali habitat in their survey. In a synthesis of literature, published and unpublished, Reading *et al.* (1997) reported Argali densities from about 0.02 to 2.3 animals per sq. km in Central Asia.

Population Structure

In 1993, 39% of Argali observed were ewes and lambs as compared to 75% in 1998. The reason for this difference is unknown, but could be the result of there being fewer rams in the survey area during 1998. We also may have missed seeing some rams during the survey. The proportion of the

Fig. 2: The study area is typified by undulating terrain and large rock outcrops

population observed as ewes (53%) and lambs (21%) during 1998 is similar to that reported by Reading *et al.* (1997) for south Gobi in Mongolia. However, 12.7% of the animals included in Reading *et al.* (1997) were of undetermined sex, while our sample only included animals classified by sex and age.

In 1998, 25% of the Argali observed were rams compared to 61% in 1993, which is higher than the 14% reported by Reading *et al.* (1997) for a ground survey in south Gobi. For a lightly hunted Marco Polo's Argali population in Kirghizstan, Fedosenko *et al.* (1995) reported a population structure of 36% females, 15% lambs, 10% yearlings, and 38% males.

A ratio of 47.1 males : 100 females was observed in 1998. This is higher than the 26.9 males : 100 females reported by Reading *et al.* (1997), but lower than the 105 males : 100 females reported by Fedosenko *et al.* (1995) for Marco Polo's Argali in Kirghizstan and 59 males : 100 females reported by Schaller (1998) for Argali (*O. ammon*) in China's Xinjiang Province. A high ratio of males to females in the study area is indicative of an unhunted population.

Table 2: Population structure of Gobi Argali (*Ovis ammon*), classified by sex and age at Ikh Nartiin, Mongolia, 1993 and 1998

Year	Total Class	Ewes	Lambs	Rams	Rams by Size Class				
					I	II	III	IV	Uncl.
1993	122	15	8	99	13	7	23	9	47
1998	131	70	28	33	1	12	2	18	0

Rams

The proportion of rams observed by size class in 1993 was 25% Class I, 14% Class II, 44% Class III, and 17% Class IV and in 1998 size classes were 3% Class I, 36% Class II, 6% Class III, and 55% Class IV. A higher number of Class II and Class IV rams were observed in 1998 compared to 1993. A lower number of Class I and Class III rams were observed in 1998 than in 1993. These differences may reflect variation in recruitment and survival rates of individual age classes over 6 years. These differences may also be partially due to sampling biases because of the short census period of 2 field days. Fedosenko *et al.* (1995) observed a male population segment structure of 31, 33, 30 and 6 percent for Class I, II, III, and IV rams, respectively, in Kirghizstan, in a lightly hunted population.

The relatively high numbers of rams in the larger size Classes (III and IV) indicate that significant numbers of rams are surviving to maturity. Significant survival of rams to maturity is further evidenced by ages of rams found dead in the field. Horns of 17 rams found in the field dead from natural causes were aged by counting annual horn growth rings (Geist

1966). The mean age at time of death was 8 years old. Ages ranged from the youngest, a 3 year old to a 13 year old. Of the 17 rams found dead of natural causes, 14 were Class IV (>6 years) and their mean age at death was about 9 years. Age at death for Class IV rams ranged from 6 to 13 years, with 2 greater than 10 years old. Geist (1991) and Schaller (1998) estimated the average life span for mature Argali rams as about 9 years. Rams at Ikh Nartiin are surviving to a similar average life span, indicating favourable habitat conditions (Hoefs and Cowan 1979).

Ewes and Lambs

During 1998 surveys, 70 ewes and 28 lambs were observed at Ikh Nartiin, yielding a ratio of 40 lambs : 100 ewes. The ratio indicated a productive population. Lambs were about 5 months old and this ratio reflects the proportion surviving the first early critical time period (Geist 1971; Hoefs and Cowan 1979). High lamb production and vigorous lambs (Geist 1971) typify high-quality wild sheep populations. Reading *et al.* (1997) observed 36.9 lambs : 100 ewes during August 1994 ground surveys in south Gobi. During late summer surveys in the south Gobi in 1993, Valdez *et al.* (1995) observed 124 females and 54 lambs, yielding a ratio of 44 lambs : 100 ewes. Fedosenko *et al.* (1995) reported a ratio of 43 lambs : 100 ewes for Marco Polo's Argali population in Kirghizstan. In the eastern Pamir of Tajikistan, Fedosenko and Weinberg (2001) reported a ratio of 41 lambs : 100 ewes for Marco Polo's Argali during a fall survey. A ratio of 41 lambs : 100 ewes was reported by Schaller (1998) for Argali on the Tibetan steppe. Harris *et al.* (2001) observed approximately 60 lambs : 100 ewes during fall surveys for Argali in Gansu Province, China. The ewe : lamb ratio at Ikh Nartiin is similar to that reported for other areas and is typical of a growing or healthy population (Geist 1971).

Population Trend and Size

The observed population densities of 0.99 per sq. km for 1993 and 1.04 Argali per sq. km for 1998 indicate a stable population trend. During the 1993 and 1998 surveys, 163.8 sq. km or 27 percent of the total Ikh Nartiin Argali range was surveyed. A minimum population estimate was calculated by extrapolating the observed density to the remaining 443.6 sq. km or 73 percent of the Argali range. Multiplying the observed densities for 1993 and 1998 by the size of the Ikh Nartiin Argali range provided a minimum population estimate of 601 and 632 Argali for 1993 and 1998, respectively. This estimate assumes that all Argali within the survey area were observed, but it is likely that all argali within the survey area were not observed. Even aerial surveys underestimate population density (Pollock and Kendall 1987). When conducting fall surveys utilizing a helicopter, the most accurate census method, one can only expect to observe 20 to 50 percent of the population (Remington and Welsh 1989).

CONCLUSIONS AND RECOMMENDATIONS

The survey data indicate that the Argali population at Ikh Nartiin is probably viable for population and genetic processes (Soule 1987; Morrison *et al.*1998). Argali occur over hundreds of thousands of sq. km of open range without obstructions like fences, canals, paved roads, heavy traffic or natural barriers. In 1993, we observed 106 Argali about 80 km southwest of the study area (44° N, 108° E) near Mandahsum village, indicating a widespread, continuous distribution of Argalis, which could travel and interbreed over large-scale landscapes. Natural population control factors may be operating because, although unhunted, the population was relatively stable between 1993 and 1998. Productivity of ewes and lamb survival through the first critical time period is similar to that reported for several other Argali populations. The high proportion of rams observed in the larger size Classes (III and IV) and mean age of about 9 years for Class IV rams found dead of natural causes, indicated good survival and that poaching is not a significant cause of mortality. The human population density in the study area is low and firearms, especially those of high calibre, are probably limited. The observed ratio of 40 lambs : 100 ewes and relatively high proportion of rams surviving to older age classes are indicators of a healthy population.

Range conditions at Ikh Nartiin are in mid to late seral stage and forage production is adequate for wild and domestic ungulates inhabiting the area. This is evidenced by the abundance of the current year's plant growth still present on the steppe near the end of the growing season and survival of rams into the older age classes.

The relatively high proportion of residual vegetation, diversity of native plants, and plant species composition indicates that livestock grazing has been light or moderate in the study area and the Argali habitat is in mid to late seral stage. During September 1993 and October 1998, most of the current year's plant growth was still present on the steppe, also indicating livestock grazing had been light.

During 1993 and 1998, few cattle, sheep, and horses were observed on the Argali range. An increase in livestock numbers could degrade habitat quality. A long-term grazing strategy for domestic livestock emphasizing sustainability of soils and vegetation while providing for the habitat needs of wild animals and human society should be developed (Valdez *et al.* 1995)

Long-term monitoring of this population should continue. Also, a management plan should be implemented that ensures the viability of the Argali population by encouraging continued protection by local herders, and includes economic incentives not to increase domestic livestock numbers. Issuing at least one license annually for trophy hunting, which would not deleteriously impact the population, should be considered as a means for funding conservation efforts by the local authorities at Ikh Nartiin. Should a hunting program be implemented, studies should be conducted to determine any social, economic, and ecological impacts. Funding from hunting can provide incentive to improve management and protection of wildlife in Mongolia (Valdez *et al.* 1995). Population parameters for this unhunted Argali population may serve as a management reference for comparison with hunted populations.

ACKNOWLEDGEMENTS

The authors acknowledge Grand Slam Club/Ovis, Safari Club International, Foundation for North American Wild Sheep, Mongol Tours, and Mongol Safaris for funding the project. We thank Dennis Campbell, Baasanhu Jantzen, B. Galdabrakh, U. Buyandelger, and Sukhiin Amgalanbaatar who, because of their dedication to the conservation of Argali, made the project possible. Gu Anlin, Research Scientist, Chinese National Academy of Agricultural Sciences assisted with plant identification. The Mongolian Ministry for Nature and the Environment, Mongolian National Agriculture University, New Mexico State University Agricultural Experiment Station, and the Montana Department of Fish, Wildlife & Parks also supported the project. In addition to anonymous referees, Dr. Carl Wambolt, Montana State University, reviewed the manuscript.

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